
7. Performance Method

7.1 Overview

The Warren-Alquist Act requires “performance standards,” which establish an energy budget for the building in terms of energy consumption per square foot of floor space. This requires a complex calculation of the estimated energy consumption of the building, and the calculation is best suited for a computer. The Energy Commission uses a public domain computer program to do these calculations. For compliance purposes it also approves the use of privately developed computer programs as alternatives to the public domain computer program. The public domain computer program and the Commission-approved privately developed programs are officially called alternative calculation methods (ACMs). The rules for approval of privately developed ACMs are contained in the *Residential and Nonresidential Alternative Calculation Method Approval Manuals* that are commonly referred to as “ACM Manuals.”

It's easiest to talk about these programs as “compliance software,” and we will use that term throughout this manual.

This chapter explains the performance method of complying with the Standards. The method works by calculating the Time Dependent Valuation (TDV) energy use of the proposed design and comparing it to the TDV energy for the standard design (the budget). The standard design is a building with the same size as the proposed design, but incorporating all features of Prescriptive Package D. The energy budget includes water heating, space heating, and space cooling. Lighting is not included in the performance calculations. If the proposed design uses equal or less TDV energy than the standard design, then the building complies. This method provides maximum flexibility because the building designer may trade-off the energy performance of different building components and design features to achieve compliance.

Compliance credit is available if the proposed design exceeds the Package D requirements in these areas. There are significant savings opportunities, including:

- Ceiling insulation
- Wall insulation
- Floor insulation
- Window performance (U-factor and SHGC)
- Fixed shading devices
- Window orientation
- Thermal mass

- Cool roof
- Air retarding wrap
- Blower door testing
- Heating and cooling equipment efficiency
- High EER air conditioners
- Quality insulation installation
- Maximum cooling capacity
- Supply duct location
- Duct insulation
- Diagnostic supply duct location, duct sealing, minimized surface area, and increased R-value
- Ducts in attics under radiant barriers
- Air handler watt draw
- Adequate cooling air flow
- Zonal control
- Water heater efficiency and distribution system type.

Credit for many of the above features cannot be taken in the prescriptive packages, but can be taken under the performance approach.

The performance method is the most popular compliance method under the Standards, with more than 90% of building permit applications being submitted in this manner. The method is especially popular with production homebuilders because they can optimize performance and achieve compliance at the lowest possible cost.

Computer programs used for compliance are approved by the Energy Commission as being capable of calculating space conditioning and water heating energy use in accordance with a detailed set of rules. The computer programs simulate or model the thermal behavior of buildings by calculating hourly heat flows into and out of the various thermal zones of the building. The tools must demonstrate their accuracy in analyzing annual space conditioning and water heating energy use of different building conservation features, levels and techniques.

- Approved computer programs must be able to:
- Automatically calculate the standard design TDV energy budget for heating, cooling, and water heating
- Calculate the TDV energy use of the proposed design in accordance with specific fixed inputs, restricted inputs and user-specified inputs
- Print the appropriate standardized compliance reports.

This chapter provides only a general overview of the performance method. Each computer program that is approved by the Energy Commission is required to have a compliance supplement that provides more detailed information regarding the use of the software for compliance purposes. The requirements for the compliance supplement along with other requirements for approved computer programs are documented in the 2005 Residential ACM Manual.

7.2 What's New for 2005

The most significant change in the performance method for the 2005 Standards is the switch to time-dependent valuation of energy rather than the previous definition of source energy. The new method favors peak energy saving measures over off peak measures.

Credit is no longer given for reduced glazing area below the prescriptive limit.

Credit is no longer given for using a central water heating system in multifamily buildings.

Form 3Rs are eliminated. U-factors for walls, ceilings and floors must now be taken from tables of constructions listed in the Joint Appendix IV.

The old C-2R is no longer necessary. The Computer Method Summary (C-2R) is combined with the CF-1R to reduce duplication.

There are several new compliance credits:

- high EER air conditioners,
- gas cooling,
- high quality insulation installation,
- properly sized air conditioners,
- efficient air conditioner fan motors, and
- ducts buried in attic insulation.

For additions and alterations, compliance credit for alterations made to an existing building is now available only if the improved measure meets or exceeds the prescriptive requirement.

7.3 The Process

Any approved computer program may be used to comply with the Standards using the performance method. The following steps are a general outline of the typical computer program procedure:

- Collect all necessary data—areas and thermal characteristics of fenestration products, walls, doors, roofs, ceilings and floors, construction assemblies, including fenestration U-factor and solar heat gain coefficients, equipment efficiencies, water heating information—from drawings and specifications.

Although most computer programs require the same basic data, some information and the manner in which it is organized may vary according to the particular program used. Refer to the compliance software compliance supplement for additional details.

- Enter data into the computer program describing the surface areas and thermal performance properties of building envelope components, water heating system and equipment, and HVAC system and equipment. Input values and assumptions must correctly correspond to the proposed design and conform to the required mandatory measures.
- Launch a computer run to automatically calculate the TDV energy of the standard design and the proposed design.

The building complies if the total TDV energy use of the proposed design is the same as or less than the standard design TDV energy budget.

When creating a computer input file, use the space provided for the project title information to concisely and uniquely describe the building being modeled. User-designated names should be clear and internally consistent with other orientations and/or buildings being analyzed. Title names and explanatory comments should assist individuals involved in both the compliance and enforcement process.

7.3.1 Defining the Standard Design

Each approved computer program must automatically calculate the TDV energy use of the standard design. The standard design is created based upon data entered for the proposed design using all the correct fixed and restricted inputs.

The computer program defines the standard design by modifying the geometry of the proposed design and inserting the building features of prescriptive Package D. This process is built into each approved computer program and the user cannot access it. Key details on how the standard design is created and calculated by the computer programs, including the listing of fixed and restricted input assumptions, is documented in the 2005 Residential ACM Manual.

The standard design assumes the same total conditioned floor area, conditioned slab floor area, and volume as the proposed design, and the same gross exterior wall area as the proposed design, except that the wall area in each of the four cardinal orientations is equal. The standard design uses the same roof/ceiling area, raised floor area, slab-on-grade area and perimeter as the proposed design, assuming the standard insulation R-values required in the prescriptive packages.

Total fenestration area in the standard design is equal to the proposed design if the fenestration area in the proposed design is less than or equal to 20% of the floor area, otherwise, the fenestration area of the standard design is equal to 20% of the floor area. Fenestration area in the standard design is evenly distributed between the four cardinal orientations. SHGC and U-factors are those listed in Package D, and no fixed shading devices such as overhangs are assumed for the standard design.

The standard design includes minimum efficiency heating and cooling equipment, as well as the minimum duct R-value with ducts in a vented attic. Ducts are assumed to be sealed as required by Package D. The standard design also has correct refrigerant charge as required by Package D.

For water heating systems that serve individual dwelling units, the standard design is a gas storage water heater with an EF of 0.575. The standard design has a standard distribution system, i.e., the first five feet of hot and cold water piping from heating source and the entire length of piping to kitchen fixtures that are $\frac{3}{4}$ in. diameter or larger are insulated as specified in §150 (j) 2A or §150 (j) 2B.

For water heating systems that serve multiple dwelling units, the standard design system type (central or individual water heaters) is the same as the proposed design system. Other details are provided in the *2005 Residential ACM Manual*.

7.3.2 Standard Reports

For consistency and ease of enforcement, the manner in which building features are reported by compliance computer programs is standardized. Energy Commission-approved computer programs must automatically produce compliance reports in this standard format. The principal report is the Certificate of Compliance (CF-1R).

The CF-1R has two highly visible sections, one for special features and modeling assumptions, and a second for features requiring field verification and/or diagnostic testing by approved HERS raters. These two sections serve as a punch list for special consideration during compliance verification by the local building department and the HERS rater. Items listed in the Special Features and Modeling Assumptions section indicate that unusual features or assumptions are used for compliance, and they call for special care by the local building department. Items listed in the HERS Required Verification section are for features that rely on diagnostic testing and independent verification by approved HERS providers/raters to ensure proper field installation. Diagnostic testing and verification by HERS providers/raters is in addition to local building department inspections.

Table 7-1 lists some of the measures that are to be listed on the CF-1R. For each measure, the table indicates whether building official verification, HERS rater field verification, or HERS rater diagnostic testing are required.

Table 7-1 – Special Features to be Listed on CF-1R

Category	Building Official Verification of Special Features	HERS Rater Verification	HERS Rater Diagnostic Testing	Measure
General	Y			Compliance for all orientations
Ducts			Y	Duct leakage
		Y		Less than 12 ft. of duct outside conditioned space
	Y			100% of ducts in crawlspace/basement
	Y			Supply registers within two ft of floor
		Y		Diagnostic supply duct location, surface area, and R-value
	Y			Ducts in attic with radiant barriers
	Y			Duct increased R-value
		Y		Buried ducts
		Y		Non-standard duct location
Envelope	Y			Air retarding wrap
			Y	Reduced infiltration (blower door). May also require mechanical ventilation.
		Y		Quality insulation installation
	Y			Solar gain targeting (for sunspaces)
	Y			Inter-zone ventilation
	Y			Radiant barrier
	Y			Non-default vent heights
	Y			Vent area greater than 10%
	Y			Exterior shades
	Y			High thermal mass
	Y			Metal framed walls
	Y			Sunspace with interzone surfaces
	Y			Cool roof
HVAC Equip		Y		Thermostatic expansion valve (TXV)
			Y	Refrigerant charge
		Y		High EER
	Y			Zonal control
		Y		Mechanical ventilation
			Y	Air handler fan power
			Y	Adequate air flow
	Y			Hydronic heating systems
		Y		Air conditioner size
Water heating	Y			Combined hydronic
	Y			Non-standard water heaters (wh/unit)
	Y			Water heater distribution credits
	Y			Non-NAECA water heater
	Y			High EF for existing water heaters

A sunspace is a passive solar system consisting of an unconditioned space facing south or near south. See computer program vendor's compliance supplement for modeling these spaces.

7.3.3 Professional Judgment

Some modeling techniques and compliance assumptions applied to the proposed design are fixed or restricted. There is little or no freedom to choose input values for compliance modeling purposes. However, other aspects of computer modeling remain for which some professional judgment is necessary. In those instances, exercise proper judgment in evaluating whether a given assumption is appropriate.

Building departments have full discretion to reject a particular input, especially if the user has not substantiated the value with supporting documentation.

Two questions may be asked in order to resolve whether professional judgment has been applied correctly in any particular case:

- Is a simplifying assumption appropriate for a specific case? If simplification reduces the predicted energy use of the proposed building when compared to a more explicit and detailed modeling assumption, the simplification is not acceptable (i.e., the simplification must reflect higher energy use than a more detailed modeling assumption).
- Is the approach or assumption used in modeling the proposed design consistent with the approach or assumption used in generating the energy budget?

One must always model the proposed design using the same assumption and/or technique used by the program in calculating the energy budget unless drawings and specifications indicate specific differences that warrant conservation credits or penalties.

Any unusual modeling approach, assumption or input value should be documented with published data and should conform to standard engineering practice.

For assistance in evaluating the appropriateness of particular input assumptions, call the Energy Hotline or call the vendor of the computer program.

7.4 Mixed Occupancy Buildings

§100(e)

Some residential buildings have areas of other occupancies, such as retail or office, in the same building. An example of this might be a three-story building with two floors of apartments above ground floor shops and offices. The first thing to consider when analyzing the energy compliance of a mixed occupancy building is the type and area of each occupancy type.

Depending on the area of the different occupancies, you may be able to demonstrate energy compliance as if the whole building is residential. This is allowed if the residential occupancy accounts for greater than 90% of the conditioned floor area of the building (or permitted space).

Note: Mandatory measures apply separately to each occupancy type regardless of the compliance approach used. For example, if complying under the mixed occupancy exception, both residential documentation (MF-1R form) and nonresidential documentation for mandatory measures must be submitted with other compliance documentation.

If the building design does not fit the criteria described above for a dominant occupancy, then the low-rise residential occupancy type must be shown to comply on its own. The remaining occupancy types must be shown to comply separately either by independent compliance for each occupancy or (for the nonresidential performance approach) by combining nonresidential occupancies in accordance with the rules of the Nonresidential ACM Manual. This may be done by using any of the approved prescriptive or performance methods available for each occupancy type. As a result, documentation for each occupancy type must also be considered separately, and a Certificate of Compliance must be submitted for each occupancy type. Note that mixed high-rise and low-rise residential occupancies will not occur in the same building because the designation applies to the building.

7.5 Multifamily Buildings

§101(b)

Envelope and HVAC equipment requirements for multifamily apartment buildings with four or more habitable stories (and hotels or motels of any number of stories) are covered by the Nonresidential Standards. These are explained in the *Nonresidential Compliance Manual*. Multifamily buildings with one to three habitable stories are considered low-rise residential buildings and are discussed in this manual.

Compliance for a low-rise multifamily building may be demonstrated either for the building as a whole or on a unit-by-unit basis. Floors and walls between dwelling units are considered to have no heat transfer, and may be ignored in performance calculations.

7.5.1 Whole Building Compliance

The simplest approach to compliance for a multifamily building is to treat the building as a whole, using any of the compliance paths described in earlier chapters. In practice, this process is similar to analyzing a single family residence except for some differences in water-heating budgets and internal gains, as explained in the *2005 Residential ACM Manual*.

7.5.2 Compliance Unit-By-Unit

The other compliance approach for multifamily buildings is to demonstrate that each dwelling unit complies separately. Each unique unit in the building, determined by orientation and floor level, must be separately modeled using an approved computer program. In this approach, surfaces, which separate dwelling units, may be ignored as they are assumed to have no heat loss or heat gain associated with them. Surfaces between dwelling units and a central corridor must be modeled if the corridor is not directly conditioned (see Joint Appendix I for definition). If it is conditioned, the corridor area may be modeled separately.

Different orientations and locations of each unit type within the building must be considered separately. That is, a one-bedroom apartment on the ground floor of a three-story building is different from the same plan on a middle floor or the top floor, even if all apartments have the same orientation and are otherwise identical. Likewise, end units must be modeled separately from the middle units; and opposite end units must both be modeled. With this approach every unit of the building must comply with the standard, so this approach is more stringent than modeling the building as a whole (see Figure 7-1).

Other options for showing unit-by-unit compliance are similar to those for subdivisions and are explained in Section 7.6 of this chapter.

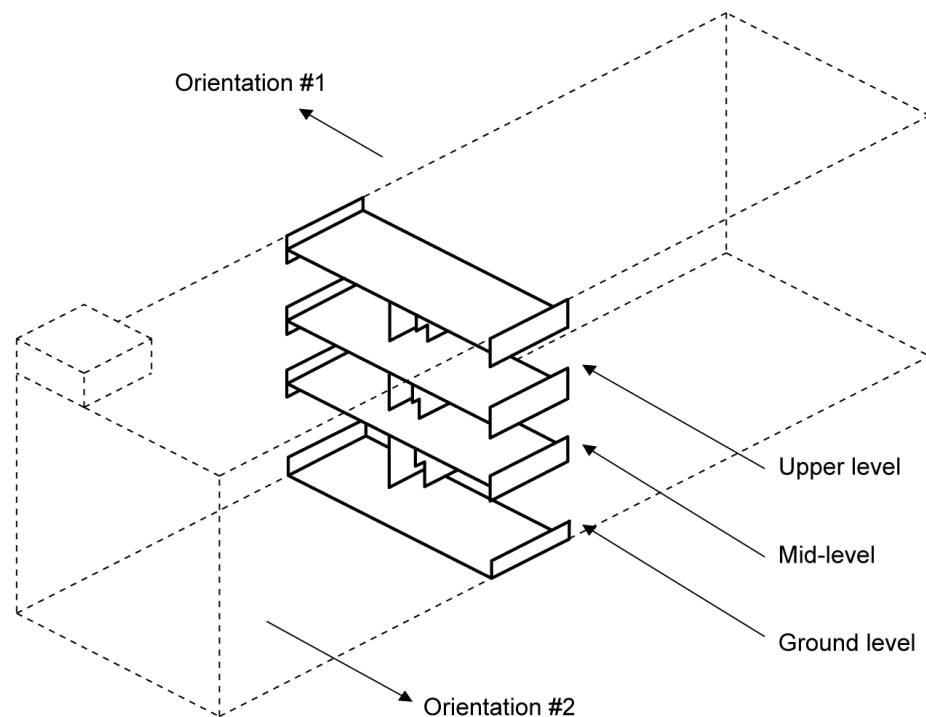


Figure 7-1– Multifamily Building Compliance Option

Demonstrate Compliance for Each Generic Unit Type in Each of its Characteristic Locations

Example 7-1**Question**

When preparing compliance calculations for a three-story apartment complex, I have the option of showing compliance for each dwelling unit or for the entire building. If I use the individual dwelling unit approach, do I need to provide calculations for every dwelling unit?

Answer

Each dwelling unit must comply with the Standards when using this approach. When dwelling units have identical conditions the calculations, can be combined. This means you will show separate compliance for all unique conditions, such as:

Front facing North

Front facing West

Front/side walls facing East and North

Front/side walls facing East and South

Middle units and both end units

Exterior roof, no exterior floor

Exterior floor, no exterior roof.

Surfaces separating two conditioned spaces (such as common walls) have little heat transfer and can be disregarded in the compliance calculations. Alternatively, you can model the entire building.

7.6 Subdivisions And Master Plans

Subdivisions often require a special approach to energy compliance, since they generally include one or a few basic building or unit plans repeated in a variety of orientations. The basic floor plans, *as drawn*, may also be used in a mirror image or *reversed* configuration.

There are two compliance options for subdivisions. They are:

- Model each individual building, or building condition, separately according to its actual orientation.
- Model all four cardinal orientations for each building or plan type with identical conservation features for no orientation restrictions.

7.6.1 Individual Building Approach

The most straightforward compliance option for subdivisions is to analyze each individual building in the project separately using any compliance method. This may be practical for subdivisions with only custom buildings, or with only one or two specific orientations for each building plan. This approach requires that each unit comply separately, with separate documentation submitted for each unit plan in the orientation in which it will be constructed.

7.6.2 Multiple Orientation Alternative: No Orientation Restrictions

§151(c)

The computer method may be used to demonstrate that a single family dwelling plan or a unit plan in a multifamily building complies regardless of how it is oriented within the same climate zone. To assure compliance in any orientation, the annual energy consumption must be calculated in each of the four cardinal orientations: true north, true east, true south and true west. With this option, the buildings must have the identical combination of conservation measures and levels in each orientation and comply with the energy budget in each case.

If a building floor plan is reversed, either the original plans or the reversed plans may be shown to comply in all four cardinal orientations. Multifamily buildings may be analyzed as a whole building using this method or on a unit-by-unit approach at the option of the permit applicant.

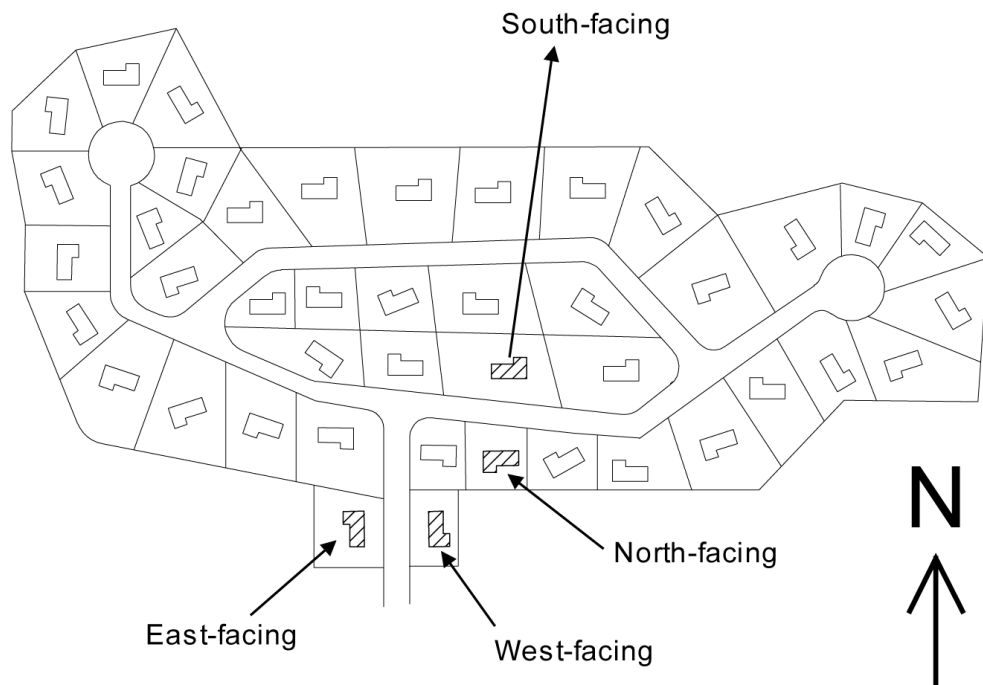


Figure 7-2– Subdivisions and Master Plans Compliance Option
Demonstrate Compliance for Each Cardinal Orientation for Each Basic Model Type

For compliance, submit documentation of the energy budgets for each of the four orientations. Only one CF-1R form is required.

7.7 HVAC Issues

7.7.1 No Cooling Installed

When a building does not have a proposed cooling system, there is no compliance credit. The air conditioning system is modeled to be equivalent to Package D.

7.7.2 Equipment without SEER

For equipment without a tested SEER, the EER is used in place of the SEER.

7.7.3 Multiple HVAC Systems

Buildings with multiple HVAC systems not meeting the zonal control criteria (see 4.4.5) may model each zone separately without taking credit for zonal control.

For buildings using more than one system type, equipment type or fuel type, where the types do not serve the same floor area, model either the building zone or enter the floor area served by each type.

For floor areas served by more than one heating system, equipment, or fuel type, indicate which system, equipment, and fuel type satisfies the heating loads. To satisfy the heating load, the equipment capacity for the specified system, equipment and fuel type must be large enough to satisfy the design heating requirements.

For floor areas served by more than one cooling system, equipment, or fuel type, indicate which system, equipment, and fuel type satisfies the cooling loads.

When there is more than one system meeting the heating or cooling load for the same space, the system that has not been selected as the proposed design for the performance compliance analysis (supplementary heating) must still meet all the mandatory requirements of the standards.

For example, an electric slab floor heating system installed in all or part of a building as supplemental heat would need to meet the slab edge insulation requirements in §118 (g) and the setback thermostat requirements of §150 (i) even though the compliance analysis uses a central gas furnace with air distribution for the entire building.

A system need not be a central system to be considered the primary system that provides heating or cooling to the space. For example, in a small apartment, a single package terminal air-conditioner or a gas wall furnace may be considered to be the primary system that provides heat to the entire apartment even though there is no distribution system (other than doorways) between the heating unit and other rooms such as the bedroom or bathroom.

If the user chooses to not install a setback thermostat on a “supplemental” heating system (exception to §150 (i)), then the user must model the supplemental system to achieve compliance. If the system without a setback

thermostat serves only a portion of the building that portion of the building is modeled with the supplemental system. The remainder of the building is modeled with the primary heating system.

7.7.4 Gas-Fired Cooling Systems

Gas-fired (absorption) cooling systems are modeled with two coefficient of performance (COP) values—one for gas and one for electric. Heating Systems using Heat Pumps

See compliance program vendor's compliance supplement for details on how to model these types of systems.

7.7.5 Cool Roofs

Compliance credit may be taken when a cool roof is installed when using the performance approach. This topic is discussed in detail in Section 3.3.7, Design Options, Cool Roofs, of this manual.

7.7.6 Existing + Addition + Alteration Approach

The performance approach may be used to show compliance for alterations in existing buildings, new additions, and Existing + Addition + Alteration. This topic is discussed in Chapter 8, Section 8.7.3 Existing + Addition + Alteration Approach of this manual.

